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European Patent Office  
Office européen des brevets



(11) Publication number:

**0 490 476 A1**

(12)

## EUROPEAN PATENT APPLICATION

(21) Application number: **91309512.1**

(51) Int. Cl.<sup>5</sup>: **D04H 13/00**

(22) Date of filing: **16.10.91**

(30) Priority: **14.12.90 US 628061**

(43) Date of publication of application:  
**17.06.92 Bulletin 92/25**

(84) Designated Contracting States:  
**AT BE CH DE DK ES FR GB GR IT LI LU NL SE**

(71) Applicant: **HERCULES INCORPORATED**  
**Hercules Plaza**  
**Wilmington Delaware 19894-0001(US)**

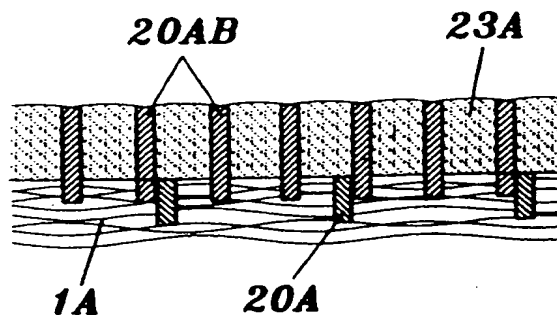
(72) Inventor: **Modrak, James Patrick**  
**3816 Clubhouse Court**  
**Conyers, Georgia 30208(US)**

(74) Representative: **Brock, Peter William et al**  
**URQUHART-DYKES & LORD 91 Wimpole**  
**Street**  
**London W1M 8AH(GB)**

(54) **High loft and high strength nonwoven fabric.**

(57) High loft durable nonwoven material comprising facing and base components and corresponding process for preparation by

- (a) forming and compiling a facing component (1A);
- (b) lightly bonding the compiled facing webs, utilizing a low density bonding pattern (20A);
- (c) laying a web (23A); and
- (d) bonding (20AB) said laid web to form a base component to said facing component, utilizing a substantially greater bonding density than employed for said facing component.



**Fig. 2**

This invention relates to a durable high loft multilayer nonwoven material characterized by both softness and retention of strength and durability commensurate with art-recognized needs for coverstock in the areas defined by disposable diapers, sanitary napkins, incontinence pads and the like, and a method for obtaining the same.

In general, such products must have a fluid-absorbent core, usually comprising one or more layers of absorbent material such as wood pulp, rayon, gauze, tissue or the like.

To protect clothing, and surrounding areas from being stained or wetted by fluids retained in such core, it is generally backed by a fluid-impervious barrier sheet.

Such fluid-absorbent core generally also has a facing of coverstock material, which covers at least the body-contacting surface of the product.

The functional purpose of the coverstock is two-fold, namely (1) to promote durability by helping to contain the loosely packed pad or core of absorbent material and (2) to insulate the wearer from continuous direct contact with moisture already retained in the absorbent pad or core. Such facing or coverstock must readily receive fluids on the side of the product that is placed against the body, so as to promote the direct and immediate transfer of each fluid application or insult into the absorbent core; the coverstock must also be essentially nonabsorbent to fluid and remain dry. It is particularly important, in this regard, to minimize potential lateral migration of fluid along the coverstock surface, even after repeated insults, and for the coverstock to continue to feel dry, smooth and soft to the touch.

It is recognized that the comfort factor (i.e. dryness, softness, resistance to rewet etc.) of diapers, pads, and the like can be substantially improved by increasing thickness or caliper of the nonwoven coverstock, to obtain increased softness while retaining a well-defined separation between the wearer's skin and the fluid-retaining core.

A number of approaches have been offered for obtaining bulkier coverstock. For example, U.S. Patent No. 4,041,951 teaches embossing a nonwoven topsheet and U.S. Patent 4,391,869 proposes limiting the amount of aqueous binder applied in a vacuum-bonding operation with airlaid nonwovens. More recently, thru-air-bonded bicomponent fiber structures have been considered. Added detail concerning general use of thru-air bonding techniques is found in an article entitled "Multilayer Nonwovens for Coverstock, Medical, and other End Uses" by J. Pirkkanen in the November 1987 issue of "Nonwovens World".

U.S. Patent No. 4,548,856 and U.K. patent application GB 2,127,865A disclose thru-air bonding procedures involving multibelt systems which form

patterned nonwoven fabric.

Also of interest is U.S. Patent No. 4,652,484 which forms a diaper liner having a layered structure, in which the first layer is comprised of 1-3 denier straight bicomponent fiber and the second layer of sterically buckled (three-dimensional crimp) 1.5 to 6 denier sterically buckled bicomponent fiber.

Improvement in mechanical strength is proposed in U.S. Patent No. 4,761,322, (Kimberly-Clark Corporation), through use of a top web layer of nonwoven laminate densely calender bonded to a bottom web layer of substantially lower bonding density.

To date, however, the art has not been able to provide nonwovens with the desired high loft while retaining flow through and sufficient dimensional stability and durability to meet market needs.

It is now found, however, that the production of durable high loft nonwoven material having acceptable liquid-flow through properties can be easily and economically achieved by

- (a) forming and compiling at least one web of staple fiber of thermoplastic material such as polyolefins, polyesters, polyamides and the like as monocomponent or bicomponent fiber, or mixtures thereof, preferably 1-5 webs, of crimped and carded staple onto a supporting surface movably biased in a machine direction;
- (b) initially lightly bonding the formed and compiled web(s) to obtain a facing component using a low density bonding pattern, the bonding points within such low density pattern not exceeding about 5% of the corresponding surface area of the facing component, and preferably about 0.5%-.5%, per unit length;

Depending upon desired softness and the bonding density of the body-contacting facing component, penetration of bonding points (i.e. lands height in calender bonding) into the formed and compiled webs is not less than about 30%, and can usefully extend from about 30%-100% based on the original thickness of the unbonded compiled web(s);

Formation of the corresponding base component (i.e. outside noncontacting surface of the nonwoven material) is then obtained by

- (c) laying at least one web comprising staple fiber and/or fibrillated film, preferably as air-laid short staple, spun staple fiber, such as crimped or uncrimped polyolefin staple up to about 0.75" in length, onto the inside face of the lightly bonded facing component, under conditions favoring arrangement of the staple fiber and/or fibrillated film in general cross- or transverse-direction relative to machine direction of the facing component; and
- (d) through bonding the web(s) of transversely

laid staple fiber or filament and/or fibrillated film to form a base component having a substantially greater bonding density than the corresponding facing component, (i.e. about 10%-20% and preferably 10%-15% based on the total surface area of the base component per unit length, to obtain the nonwoven material.

The term "general transverse-direction" for present purposes is defined as an arrangement of at least a majority of air-laid fiber or filaments, laid down by means hereafter described at an angle of more than about 45° and less than about 135° compared to the machine direction of the facing component.

The term "substantially greater bonding density" as applied to the base component, in comparison with the facing component, relates to relative number of bonding areas within a general ratio of about 1 (facing)-to-(3-10) base and preferably about (1) to (3-5). Such areas can optionally vary in depth of penetration.

High loft nonwovens within the scope of the present invention comprise, in combination

(A) a facing component defining a water permeable body-contacting surface comprising at least one lightly bonded web of staple thermoplastic fiber or filament; and preferably about 1-5 webs;

(B) a base component defining an external surface of the nonwoven and comprised of at least one web of short thermoplastic staple fiber or filament favoring arrangement in general cross- or transverse direction relative to the machine direction of the bonded facing component and having a substantially greater bonding density than the facing component; and

(C) an optional gate layer comprising up to about 2 perforated (perforations or interspaces preferably totaling about 10% to about 90% of total area) and/or fibrillated films arranged between the facing component and the base component, and through bonded to the facing and/or base component(s).

Representative nonwovens of the above desirable type are here shown as cross sectional schematics in Figures 2, 3 and 5, and obtained by processing represented in Figures 1, 4 and 6, in which Figure 1 schematically represents part of a production line for nonwovens having high loft and durability characteristics, in which a plurality of compiled, crimped and carded staple fiber-containing webs (1) of spinnable mono- and/or bicomponent thermoplastics, inclusive of polyolefins and preferably of 1"-3" inch staple length and about 1-15 dpf, are produced and arranged in general machine direction onto a continuous belt (2) mounted on rollers (3) rotatably activated by means not shown; the webs are passed through a first cal-

ender such as a plain anvil roller (4) and a heated patterned mandrel (5), whose lands or bonding points (12) are schematically represented as peripherally located teeth, the resulting bonding points being shown as homogeneous in length and structure, and of sufficient depth to produce bonding loci or patterns (20) shown as rectangular shaded areas, and extending to a depth of about 30%-100% of the thickness of the unbonded compiled facing webs (1). The resulting lightly-bonded facing is then passed through a conventional fiber air-laying device comprising a suction box (6) with a bottom vacuum outlet (7) having sufficient capacity to balance, volume-wise, against air and staple fiber as supplied through feeder lines (8) and feedably connected to two circumferentially slotted and rotatably-mounted cylindrical-shaped forming heads (11) (shown end-wise) possessing axially oriented slots (not shown) of sufficient width and length to permit deposit of a base layer (23) of short uncrimped staple fiber (13) of homogeneous or mixed denier onto moving bonded facing (1), the forming heads and slots being positioned to favor fiber deposit in a general cross direction transverse to the machine direction of belt (2) and bonded facing component (1), the mounting means and rotating means for forming heads (11) are not shown. The coated facing is then passed by belt (2) to a second calender shown as a plain anvil roll (17) and a heated patterned roll (15) equipped with a plurality of lands, represented as teeth (16) of sufficient depth and number to bond fibers (13) to facing component (1) (Ref., Fig. 2) and to provide a base surface (23) capable of direct or indirect fluid-feedable contact with a conventional fluid-retaining core or liquid-holding component (not shown) in a final product.

Bonding patterns (20) in the facing component and the base component are represented schematically as discrete lines or as shaded rectangular areas (See Fig. 2) rather than factually as a patterned collection of bond points or beads, and the length or depth of penetration of such bonding patterns into facing component (1) is optionally shown as less than 100% penetration while the corresponding base component (23) side, formed of bonded transversely-laid fiber (13), is shown as fully penetrated and normally extends at least down to the interface with facing component (1). The depth of penetration depends upon the desired amount of loft and durability.

Figure 2 represents a schematic break away cross section of a nonwoven of a type obtainable in accordance with Figure 1, in which bonded facing component (1A), on the body-contacting side of a nonwoven coversheet is lightly bonded (20A), compared with the occurrence of bonding points (20AB) in base component (23A). As shown, the

bonded areas (20AB) and (20A) can overlap through, a common internal area within the non-woven.

Figure 3 represents, in cross section, a modification of Figure 2, in which one or more layer of a fibrillated film, or perforated film (21B) initially compiled onto carded fiber web(s) of facing component (1B) and through bonded (20B) to form an intermediate zone to which the base component (23B) can, in turn, be easily bonded (20BB).

A modification of the partial production line of Fig. 1 for producing the type material represented in Figure 3, is shown schematically in Figure 4, in which the same or similar components share common arabic numerals in the preceding Figures, the perforated or fibrillated film (21C) being conveniently applied from feed roll (22C) or processed in situ at some point between roll (22C) and the first bonding operation. In operation, film (21C) and unbonded compiled facing web(s) (1C) are through bonded as a unit, using anvil roll 4C and heated mandrel (5C). The remaining process steps and components are as described with respect to Figure 1.

Figure 5 schematically demonstrates a cross section of a modification of Figures 2 and 3, in which perforated or fibrillated film (21D) and transversely oriented staple fiber (13P) forming a base layer (23D) are applied onto a prebonded (20D) facing component (1D) and bonded (20DB) through fibrillated- or perforated-film (21D) as in Figure 6. Identical arabic numbers represent the same or similar components and parts.

Figure 6 schematically represents a process or technique whereby one or more of fibrillated and/or perforated film (21E) are applied from feed roll (22E) onto a prebonded facing component (1E) prior to passage through suction box 6E, the remaining steps and components being similar to those described in Fig. 1.

In Figures 3, 4, 5 and 6 the interface or gate layer identified as 22B, 22C, 22D and 22E represents one or several films which can possess (a) a higher (b) a lower, or (c) the same softening and melting points as corresponding monocomponent staple fiber or the sheath layer of bicomponent fiber utilized in webs forming the facing and/or base components.

For present purposes the melting or softening point of the thermoplastic fibrillated or perforated film of the interface layer such as polyolefin or other thermoplastic film, can possess at least a 5°C and preferably a 5°C-20°C higher melting or softening point than the adjacent staple fiber or filament of the facing and/or base component(s) and can be arranged in a machine direction, in cross direction, or a mixture thereof.

Bonding techniques known and practiced in the

art, inclusive of spray or roll-applied binder material, heated calender roll(s), directed hot air, sonic and laser bonding techniques can be used singly or in combination in accordance with the present concept, provided the above-described, bonding steps and parameters are followed, and the facing and base components are laid down in the order described.

Fiber or filament used to form webs of the facing component is preferably spun from polyolefins such as isotactic polypropylene alone or combined with similar hydrophobic polyolefins and/or nonwoven copolymers thereof, the degraded spin melt conveniently having a weight average varying from about  $1 \times 10^5$  to about  $5 \times 10^5$ , a molecular weight distribution of about 3.0-8.0, a melt flow rate of about 2.5 to about 40 g/10 min., plus a spin temperature within a range of about 220°C-310°C.

Also includible within the spun melt used to form staple fiber for webs are various art-recognized fiber additives including lubricants, and antistatic agents, pH stabilizers such as calcium stearate, antioxidants, pigments, including whiteners and colorants such as  $\text{TiO}_2$  and the like. Spun fiber or filament used to form webs used in the present invention preferably comprise spun melt staple fiber, filaments or fibrillated film of bicomponent or monofilament types which are topically or otherwise treated with surfactants and/or lubricants prior to cutting and carding steps.

As above noted, webs used to fabricate nonwoven material of the present invention can usefully comprise conventional crimped monocomponent as well as concentric or non-concentric sheath/core or side-by-side-type bicomponent fiber. Suitable sheath/core fibers may include polyethylene/polypropylene, polyethylene/polyester, and polypropylene/polyester, as well as copolyester/polyester combinations, preferably within a range of about 1-3/3-6 denier.

Also within the scope of the present invention are nonwovens comprised of one or more bonded webs of modifier-treated polyolefin fiber- and/or fiber-like (fibrillated film) components having a mixed fiber denier of homogeneous and/or bicomponent types not exceeding about 40 dpf. Such webs as above noted preferably utilize fiber or filaments within a range of about 1-15 dpf.

In addition, webs used in forming nonwovens within the scope of the present invention are produced from one or more types of conventionally spun fibers or filaments having, for instance, round, delta, trilobal, or diamond cross sectional configurations.

## Claims

1. A method for obtaining durable high loft nonwoven material comprising
  - (a) forming and compiling at least one web of staple fiber of thermoplastic material, on a supporting surface movably biased in machine direction;
  - (b) initially lightly bonding the formed and compiled web(s) to obtain a facing component, using a low density bonding pattern;
  - (c) laying at least one web comprising staple fiber onto the inside face of the lightly bonded facing component, favoring arrangement in general transverse-direction relative to machine direction of said facing component; and
  - (d) through bonding the web(s) of transversely-laid staple fiber to form a base component having a substantially greater bonding density than said facing component, to obtain the desired nonwoven material.
2. The method of claim 1 wherein the (b) bonding step imparts a low density bonding pattern to the facing component not exceeding about 5% of the corresponding surface area of the facing component within said desired nonwoven material.
3. The method of claim 2 wherein the (b) bonding step imparts a bonding pattern whose penetration into the facing component is not less than about 30% of the thickness of the corresponding unbonded compiled web(s) forming said facing component.
4. The method of claim 1 wherein perforated or fibrillated film is applied to facing web(s) and through bonded thereto to form said facing component.
5. The method of claim 1 wherein perforated or fibrillated film is interposed between the facing component and base web(s) and said base web(s) through bonded to said perforated and/or fibrillated film to form the base component.
6. The method of claim 1 wherein said facing component comprises at least one web of crimped and carded polyolefin staple fiber or filament.
7. The method of claim 2 wherein the (b) bonding step imparts a pattern which is bonded through the formed and compiled web(s) of the facing component.
8. The method of claim 4 wherein the perforated-and/or fibrillated film has a higher melting and softening point than staple fiber or filament in fiber comprising the facing component.
9. A method of claim 6 wherein staple fiber forming the facing component comprises polypropylene and polyethylene-containing bicomponent fiber.
10. A method of claim 7 wherein the staple fiber forming the base component comprises polypropylene- and polyethylene-containing bicomponent fiber.
11. A high loft nonwoven material comprising, in combination,
  - (A) a facing component defining a water-permeable body-contacting surface comprised of at least one lightly bonded web of staple thermoplastic fiber or filament;
  - (B) a base component defining an external surface of said nonwoven and comprised of at least one web of short thermoplastic staple fiber or filament favoring arrangement in general cross- or transverse-direction relative to the machine direction of said bonded facing component and having a substantially greater bonding density than said facing component; and
  - (C) up to about 2 perforated and/or fibrillated films arranged intermediate said facing component and said base component, and through bonded to said facing component or to said base component.
12. The nonwoven material of claim 11 wherein the lightly bonded facing component has a bonding pattern not exceeding about 5% of the surface area of the facing component internal to said nonwoven material and said pattern has a penetration of not less than about 30% of the thickness of the unbonded compiled web(s) forming said facing component.
13. A disposable diaper comprising, in combination, a fluid-impervious order barrier sheet, a fluid absorbing core component, and a facing of coverstock material interposed between said re component and a fluid source wherein said coverstock material is a high loft nonwoven obtained in accordance with claim 1.

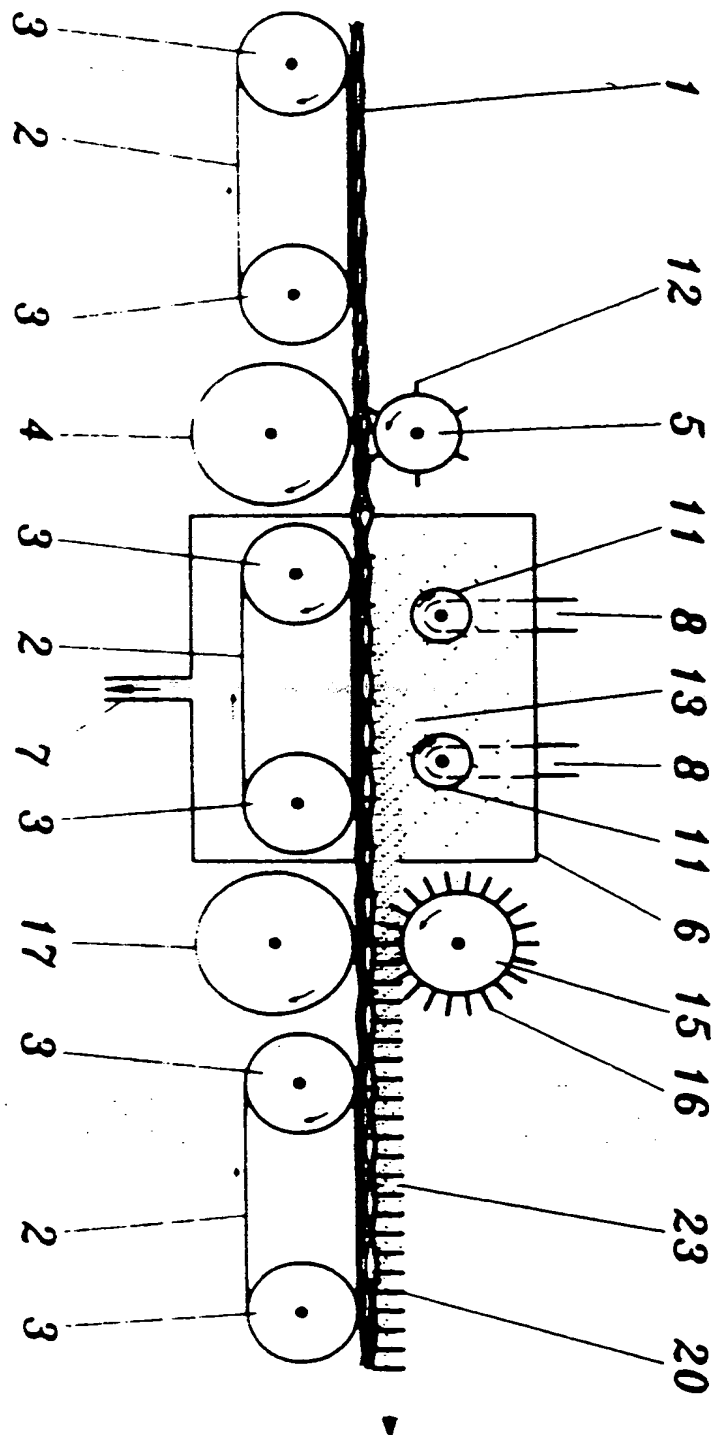
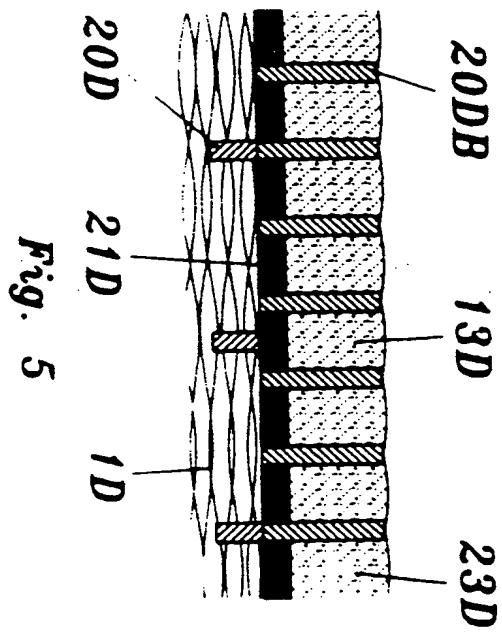
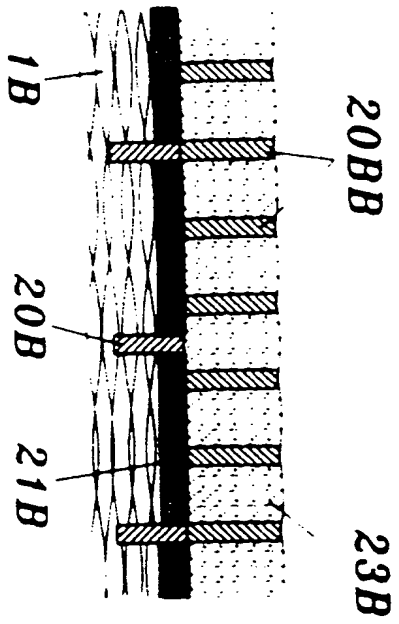
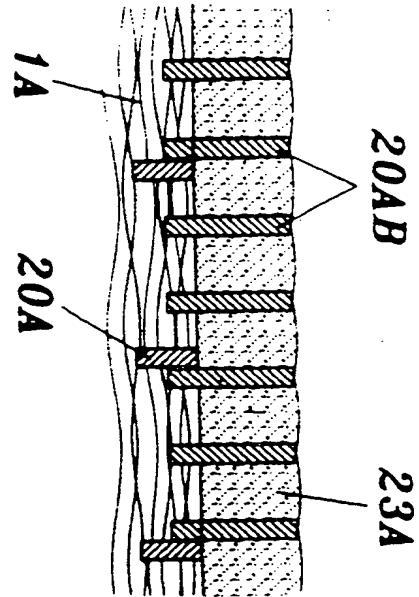


Fig. 1



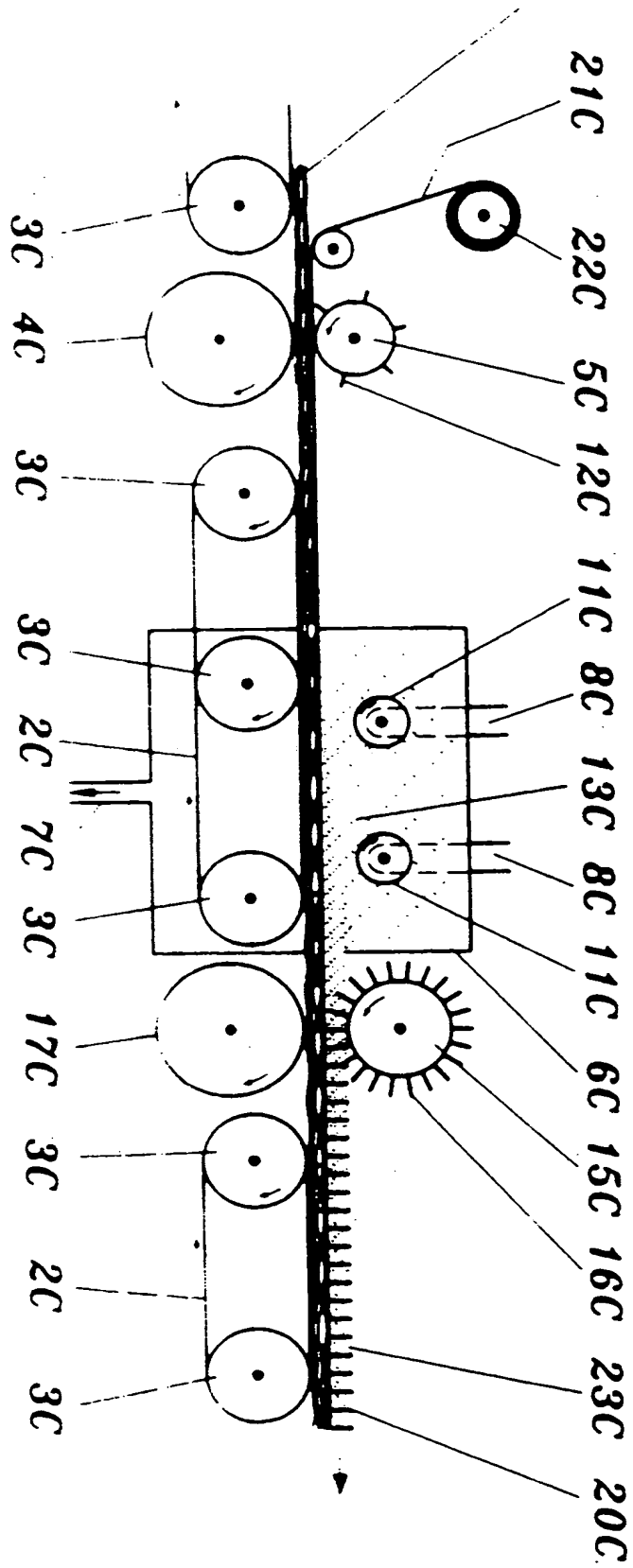


Fig. 4



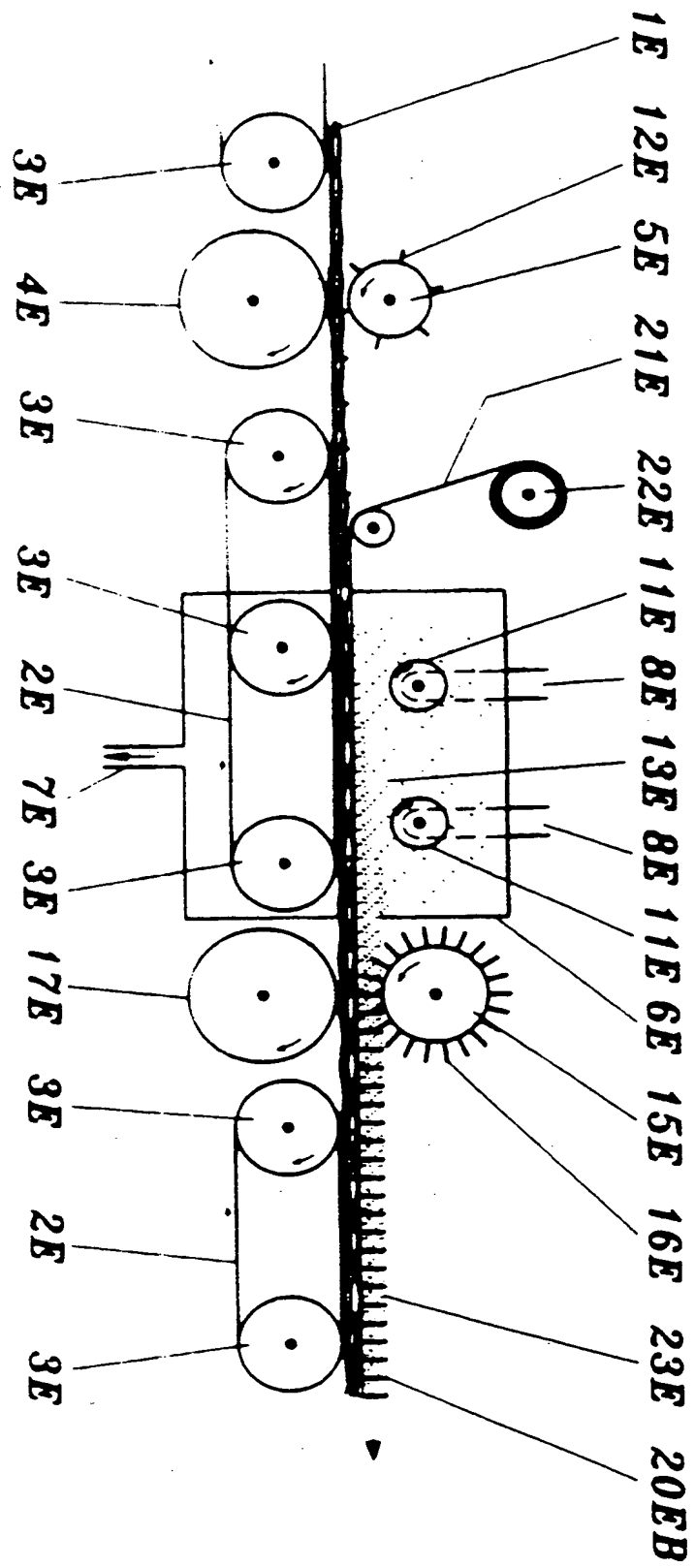


Fig. 6



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## EUROPEAN SEARCH REPORT

Application Number

EP 91 30 9512

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
A	EP-A-0 171 807 (CHICOPEE) * page 1-7; claims 1-14 *	1-4, 7-13	D04H13/00
A	DE-A-2 746 146 (HERCULES) * claims 1-3, 16, 17, 31 *	1, 11, 12	
A	US-A-4 355 066 (KENDALL) * the whole document *	1-13	
A	US-A-4 659 614 (PERFECT FIT) * the whole document *	1-13	
A, D	US-A-4 761 322 (JOHN M. RALEY) * the whole document *	1-3, 11	
			TECHNICAL FIELDS SEARCHED (Int. Cl.5)
			D04H
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 16 MARCH 1992	Examiner DURAND F.C.
<b>CATEGORY OF CITED DOCUMENTS</b>			
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document			
I : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			